## REMARKS

Reconsideration and allowance of this application, as amended, is respectfully requested. The Specification has been amended to correct various typographical errors. Claims 1-20 were pending in this application prior to entry of the abovementioned amendments. Claims 1-3, 5-7, 9-13 and 15-17 have been amended. Claims 21-28 have been added. No new matter is added by any of these amendments. Claims 4, 8, 14 and 18-20 are herein cancelled. Accordingly, Claims 1-3, 5-7, 9-13, 15-17 and 21-28 are now pending.

Applicants submit that this application, as amended, is in condition for allowance and such action is earnestly requested. The Examiner's reason for rejection is addressed below.

**Amendments to the claims**

The specification has been amended to correct typographical errors.

**Amendments to the claims**

Claim 1 has been amended to clarify the invention. Claim 1, as amended, recites, *inter alia*, "forming a copper layer on said barrier layer using chemical vapor deposition (CVD)." This amendment is fully supported by the application as originally filed ("the Application") at, for example, paragraph [0025] and original Claim 4.

Claim 10 has been amended to clarify the invention. Claim 10, as amended, recites, *inter alia*, "forming an adhesion layer on said barrier layer using ruthenium (Ru) or rhenium (Re) or their alloys using an atomic layer deposition method; and forming a copper layer on a surface of said adhesion layer, wherein forming said copper layer comprises using chemical vapor deposition (CVD)." This amendment is fully supported by the Application at, for example, paragraph [0027] and original Claim 18.

Claim 5 and 15 have been amended to clarify the invention. Claims 5 and 15, as amended, recite, "wherein forming said copper layer comprises using iodine or an iodine compound as a catalyst for CVD." These amendments are fully supported by the Application at, for example, paragraph [0029] and original Claims 5 and 15.

Claims 7 and 17 have been amended to clarify the invention. Claim 7 and 17, as amended, recite, "wherein forming said copper layer comprises sequentially using CVD followed

by the electroplating method." These amendments are supported by the Application at, for example, paragraph [0032].

Claims 2, 3, 6, 9, 11, 12, 13 and 16 have been amended to correct various typographical errors and to match follow-on recitations with their antecedents in Claims 1 and 10.

New Claims 21-28 have been added. New Claims 21 and 25 recite, "wherein using CVD comprises using a fluorine-containing copper precursor"; New Claims 22 and 26 recite, "wherein using CVD comprises using a carbon-containing copper precursor"; New Claims 23 and 27 recite, "wherein using CVD comprises using a copper precursor comprising hexafluoroacetylacetonate (hfac); and New Claims 24 and 28 recite, "wherein said copper precursor includes (hexafluoroacetylacetonate)Cu(vinyltrimethylsilane), or (hfac)Cu(vtms)." The new claims are fully supported by the Application at, for example, paragraph [0025], which teaches that (hfac)Cu(vtms) can be used to form the copper layer using chemical vapor deposition (CVD). "(hfac)Cu(vtms)" is chemical shorthand for (hexafluoroacetylacetonate)Cu(vinyltrimethylsilane), which is both a fluorine-containing (hexa***fluoro***acetylacetonate) and carbon-containing (hexafluoro***acetylacetonate***, ***vinyl***tri***methy***lsilane) compound.

**Objections to the claims**

Claims 3 and 13 are objected to because the Examiner alleges that ALD, as recited in Claims 1 and 10, is considered broader than PEALD, as recited in Claims 3 and 13. Claim 8 is objected to because the Examiner alleges that the limitation "rhenium (Re) or rhenium alloy," as recited in Claim 8, is already recited by the limitation of "ruthenium (Ru) or rhenium (Re) or their alloys," as recited in Claim 1. Claim 18 is objected to because the Examiner alleges that the limitation "ruthenium (Ru) or ruthenium alloys," as recited in Claim 10, cannot be changed to another limitation by use of "rhenium (Re) or rhenium alloys are used in place of ruthenium (Ru) or ruthenium alloys," as recited in Claim 18.

Applicants have amended the claims (see above) to address each of the Examiner's objections. Accordingly, Applicants respectfully request that objections to the claims be withdrawn.

**§112 rejection**

Claim 20 stands rejected under 35 U.S.C. §112 as being indefinite for failing to particularly point out and distinctly claim the subject matter which Applicants regard as the invention. The Examiner has found that "in place of ruthenium (Ru) or ruthenium alloys, one of the materials including nickel (Ni)...for forming a barrier layer," as recited in Claim 20, is inconsistent with "forming an adhesion layer on said barrier layer using ruthenium (Ru) or ruthenium alloys," as recited in Claim 10.

Applicants submit that the §112 rejection of Claim 20 is moot in view of the cancellation of Claim 20.

**§102 rejection**

Claims 10-11, 14 and 16-18 are rejected under 35 U.S.C. §102(a) as being anticipated by U.S. Patent No. 6,482,740 to Soininen et al. ("Soininen"). The Examiner has found that Soininen discloses all of the limitations of Claim 10, in addition to the limitations of dependent Claims 11, 14 and 16-18. Regarding Claims 14, the Examiner alleges that Soininen teaches that "said copper is formed using CVD method and/or electroplating method."

Initially, Applicants describe problems in forming a copper layer using chemical vapor deposition (CVD), namely that fluorine and/or carbon contaminants promote poor adhesion between the barrier layer and the copper layer. *See* paragraph [0010] of the Specification. In some embodiments, Applicants teach that a fluorine and carbon-containing copper source chemical (*e.g.*, (hfac)Cu(vtms)) could be used in combination with a barrier layer formed of Ru and/or Re (*i.e.*, materials that do not bind carbon and fluorine readily). *See* paragraphs [0025]-[0027] of the Specification. Soininen did not realize the contamination problem, let alone realize that such a problem could be mitigated by using CVD of certain copper precursors (*e.g.*, (hfac)Cu(vtms)) on seed layers formed of Ru and Re.

Applicants submit that Claim 10, as amended, is allowable over Soininen because Soininen neither teaches nor includes "forming an adhesion layer on said barrier layer using ***ruthenium (Ru) or rhenium (Re) or their alloys***...and forming a copper layer on a surface of said adhesion layer...***using chemical vapor deposition (CVD)***," as recited in amended Claim 10. Soininen merely mentions Cu CVD as an alternative to Cu electroplating in its Background of

the Invention ("Background") section—Soininen's preferred embodiments do not teach or include the combination of forming said Ru and Re layers and forming a Cu layer by CVD. Rather, Soininen's preferred embodiments teach forming seed layers for ***electroplating***. *See* Soininen, col. 7, lines 35-37. In fact, by combining Soininen's preferred embodiments (teaching, *e.g.*, forming Ru and Re seed layers) with its mention of CVD in its Background section, the examiner is effectively combining two ***separate*** teachings in Soininen—mention of Cu CVD in its Background section and Ru and Re seed layers for Cu electroplating—without any teaching or suggestion from the prior art to make that combination. Accordingly, as Soininen neither teaches nor suggests the limitations of amended Claim 10, Applicants respectfully request that the §102 rejection of Claim 10 be withdrawn.

Claims 11, 16 and 17 depend from and therefore include all of the limitations of Claim 10, in addition to reciting particular features of advantage and utility. Soininen neither teaches nor includes the limitations of amended Claim 10, let alone the unique combination of limitations of Claims 11, 16 and 17. Accordingly, Applicants respectfully request that the §102 rejection of Claims 11, 16 and 17 also be withdrawn.

Applicants submit that the §102 rejection of Claims 14 and 18 is moot in view of the cancellation of Claims 14 and 18.

**§103 rejection**

Claims 1, 4 and 6-8 stand rejected under 35 U.S.C. §103(a) as being unpatentable over U.S. Patent No. 5,637,533 to Choi ("Choi") in view of U.S. Patent Publication No. 2001/0013617 to Toyoda et al. ("Toyoda") and Soininen. The Examiner has found that Choi teaches all of the limitations of Claim 1 with the exception that Choi's barrier layer is made of ruthenium oxide, not ruthenium, and is formed using physical vapor deposition (PVD), not ALD. However, the Examiner has found that Toyoda and Soininen meet the deficiencies of Choi. The Examiner has found that Toyoda teaches that "ruthenium is known to be effective as a diffusion barrier", and that Soininen teaches depositing metals, including ruthenium and rhenium, using an ALD type process.

Applicants submit that Claim 1, as amended, is allowable over the combination of Choi with Toyoda and Soininen because the asserted combination does not teach or include "forming a

barrier layer using ruthenium (Ru) or rhenium (Re) or their alloys on a surface of an insulation layer on said substrate...and forming a copper layer on said barrier layer using chemical vapor deposition (CVD)," as recited in amended Claim 1. As noted above, Soininen in its Background section merely teaches that CVD of Cu could be used as an alternative to Cu electroplating. However, no connection is made between CVD and Ru or Re seed layers. Soininen neither teaches nor suggests forming a Cu layer by CVD on Ru and Re barrier seed layers, and neither Choi nor Toyoda meet this deficiency. As the asserted combination of Choi with Toyoda and Soininen does not meet the language of Claim 1, Applicants respectfully request that the §103 rejection of Claim 1 be withdrawn.

Claims 6 and 7 depend from and therefore include all of the limitations of Claim 1, in addition to reciting particular features of advantage and utility. The asserted combination of Choi with Toyoda and Soininen neither teaches nor includes the limitations of amended Claim 1, let alone the unique combination of limitations of Claims 6 and 7. Accordingly, Applicants respectfully request that the §103 rejection of Claims 6 and 7 also be withdrawn.

Applicants submit that the §103 rejection of Claims 4 and 8 is moot in view of the cancellation of Claims 4 and 8.

Dependent Claims 2-3, 5 and 9 are rejected under 35 U.S.C. §103(a) as being unpatentable over the combination of Choi, Toyoda and Soininen, as applied to Claims 1, 4 and 6-8, and further in view of U.S. Patent No. 6,936,535 to Kim et al. ("Kim") and U.S. Patent No. 6,720,262 to Koh et al. ("Koh"). The Examiner has found that the combination of Choi, Toyoda and Soininen teaches the limitations of Claims 2-3, 5 and 9 with the exception of the atomic ratio of ruthenium (Claim 2), plasma enhanced ALD (PEALD) (Claim 3), and use of iodine as a catalyst for copper CVD (Claim 5). However, the Examiner has found that Kim teaches that a reactive metal layer may be deposited by PEALD and that Koh teaches using iodine or bromine as a catalyst during copper CVD, and that it would have been obvious to one of ordinary skill in the art to combine Choi, Toyoda and Soininen with Kim and Koh to meet the language of Claims 2 and 3. With respect to Claim 9, the Examiner has found that the "[c]hoice of ratio of elements would have been a matter of routine optimization...[o]ne of ordinary skill in the art would have been led to the recited ratio of elements through routine optimization to achieve the desired deposition and reaction rates."

Without acquiescing in the Examiner's reasons for rejection, Applicants submit that Claims 2-3, 5 and 9 are allowable because they depend from and therefore include all of the limitations of Claim 1, in addition to reciting particular features of advantage and utility. Soininen neither teaches nor suggests any connection between CVD of a Cu layer and use of a Ru or Re seed layer, and none of Choi, Toyoda, Kim and Koh meets this deficiency. Accordingly, Applicants respectfully request that the §103 rejection of Claims 2-3, 5 and 9 be withdrawn.

Dependent Claims 12-13, 15 and 19 are rejected under 35 U.S.C. §103(a) as being unpatentable over Soininen, as applied to Claims 10-11, 14 and 16-18, and in view of Kim and Koh. The Examiner has found that Soininen discloses "substantially all of the instant invention but lacks the atomic ratio of ruthenium or rhenium, PEALD and iodine as a catalyst for copper CVD." The Examiner has found that Kim and Koh meet the deficiencies of Soininen in the manner discussed above in regards to Claims 2-3, 5 and 9.

Without acquiescing in the Examiner's reasons for rejection, Applicants submit that Claims 12-13 and 15 are allowable because they depend from and therefore include all of the limitations of Claim 10, in addition to reciting particular features of advantage and utility. Soininen neither teaches nor suggests CVD of a Cu layer on a Ru or Re seed layer, and neither Kim nor Koh meets this deficiency. Accordingly, Applicants respectfully request that the §103 rejection of Claims 12-13 and 15 be withdrawn.

Applicants submit that the §103 rejection of Claim 19 is moot in view of the cancellation of Claim 19.

## CONCLUSIONS

In view of the foregoing remarks, Applicants respectfully submit that the application is in condition for allowance and request the same. If, however, some issue remains that the Examiner feels could be addressed by Examiner amendment, the Examiner is cordially invited to call the undersigned for authorization.

Please charge any additional fees, including any fees for additional extension of time, or credit overpayment to Deposit Account No. 11-1410.

Respectfully submitted,

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